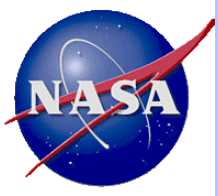


ANTHROPOMETRY & BIOMECHANICS

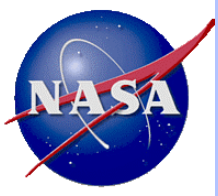
Sudhakar L. Rajulu, Ph.D.



Anthropometry & Biomechanics Facility (ABF)

Purpose and Responsibility

- ❑ Conduct research on flight equipment and EVA/IVA operations from the perspective of biomechanics, human performance, and ergonomics.
- ❑ Evaluate the equipment and the tools utilized by crews (Prototype suits for lunar and Mars, new exercise devices for ISS.)
- ❑ Anthropometric Initiative- Center wide consolidation of anthropometric and biomechanical data.



Anthropometry & Biomechanics Facility (ABF)

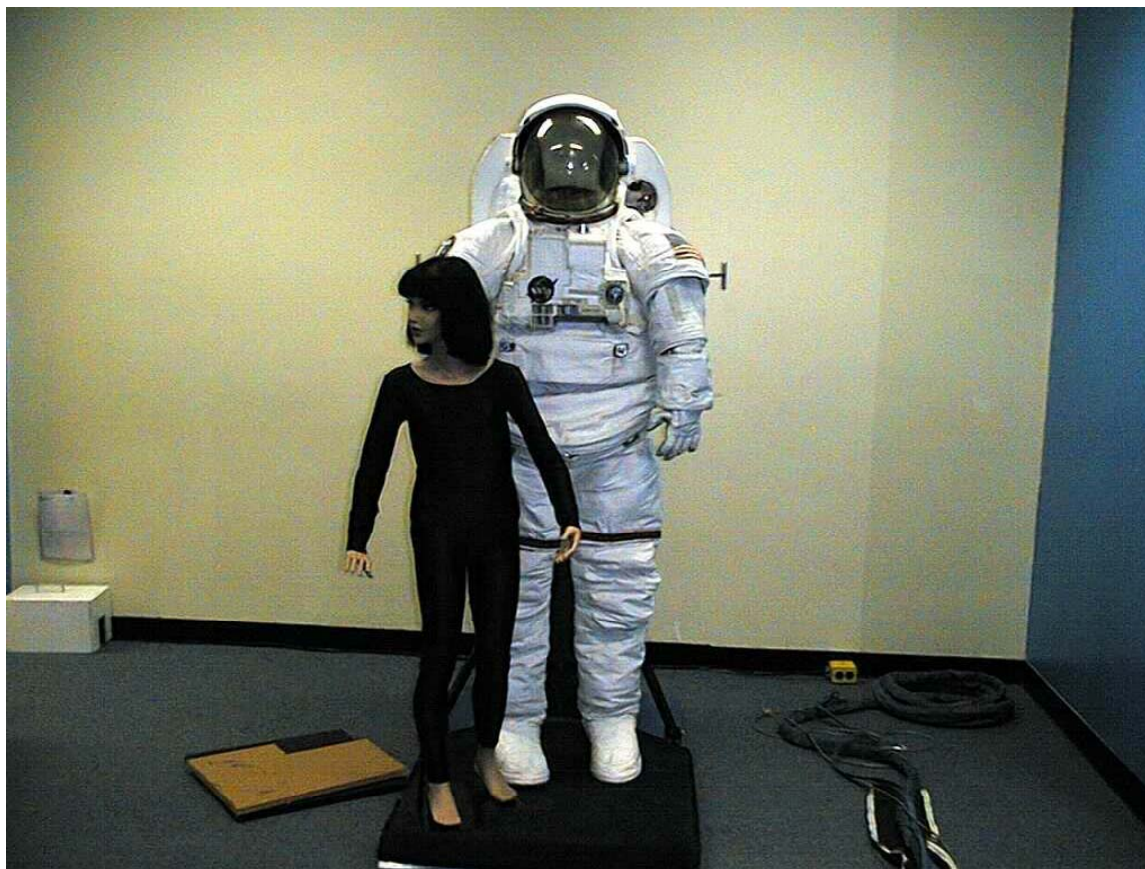
Activities

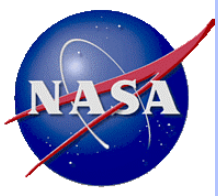
- ❑ Sample of activities conducted by the ABF.
 - ✓ Perform **Gap Analysis** on Crew-Hardware Compatibility (fig 1)
 - ✓ Measure, maintain, and provide **3-D Anthropometric and Functional strength data bases** for those who design and develop hardware
 - ✓ Assess issues pertaining to **crew induced loads** to structures.
 - ✓ Perform **longitudinal studies** on crewmembers' physical capabilities



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Figure 1: Example of a crew-hardware incompatibility

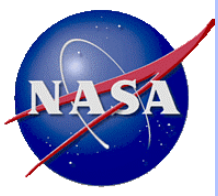




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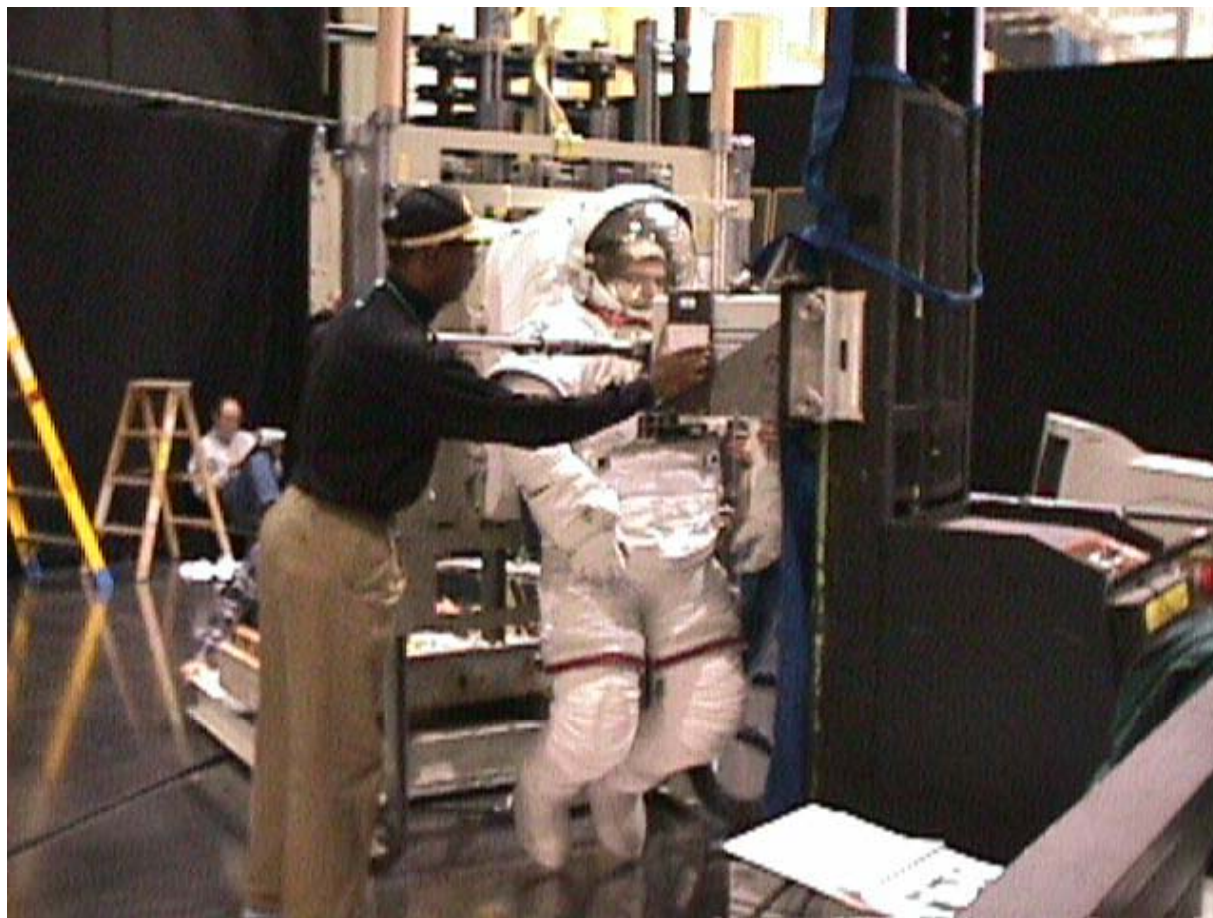
Activities cont'd

- ✓ **Evaluate and certify** the Advanced Space Hardware (Example: Quantify the reach and mobility characteristics of developmental suits for Mars and lunar exploration (Fig 2))
- ✓ Evaluate the **performance capabilities** of International Space Station work aids (CETA, ORU/OTD, BRT/MUT)
- ✓ Provide **criteria / guidelines** on modifications
- ✓ **Assess the severity** of a Problem (ORU/OTD Installation Issue, Hubble Space Telescope repair activities)



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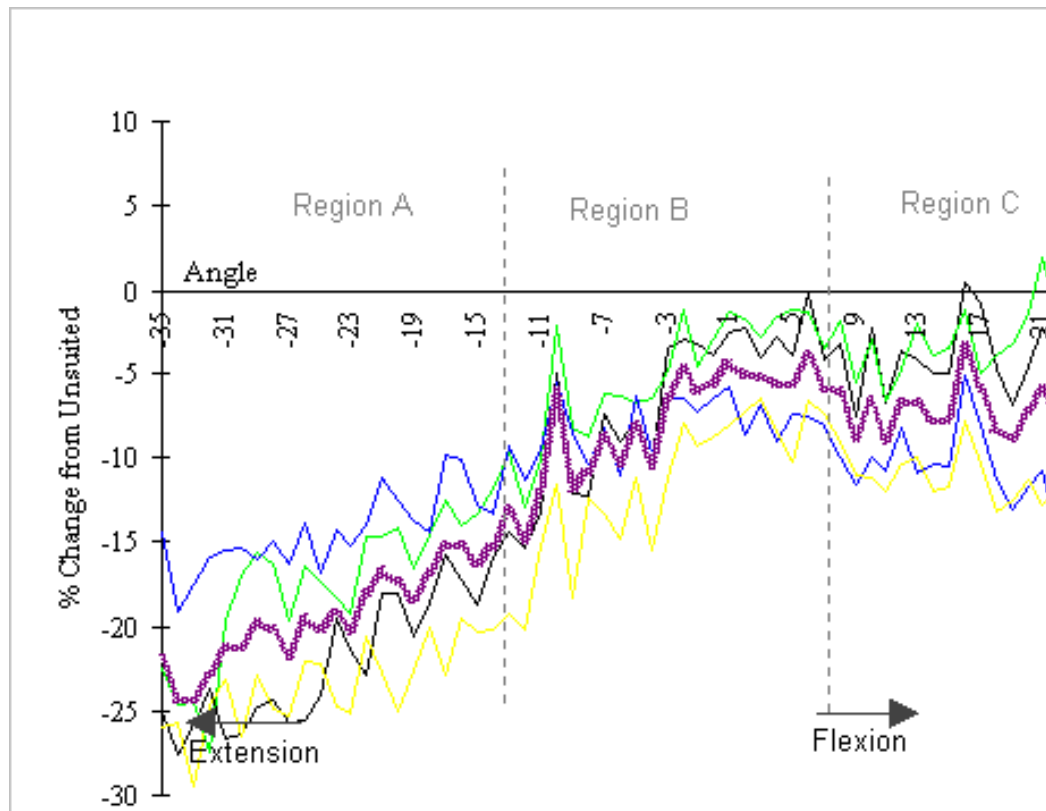
Figure 2:
Quantifying the
strength while
wearing a
pressurized suit.

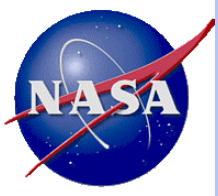




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Figure 3 – An example showing the strength and fatigue characteristics of a suited personnel.

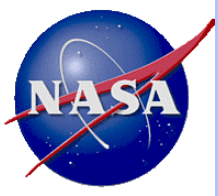




Anthropometry & Biomechanics Facility (ABF)

Instrumentation

- ✓ Whole Body and Foot Scanners
- ✓ Anthropometers
- ✓ Video based motion analysis system
- ✓ Multimodal, Multiaxial Isokinetic Device (MMID),
- ✓ Biodex and Loredan LIDO Isokinetic Strength
Dynamometers
- ✓ 6 degrees of freedom Force Plates
- ✓ Hand Dynamometer
- ✓ Pinch Dynamometer



Anthropometry & Biomechanics Facility (ABF)

Capabilities

- ❑ Data collection can be performed at the Precision Air Bearing Floor (frictionless environment in two dimensions)
- ❑ KC-135 (free fall based zero gravity environment)
- ❑ Neutral Buoyancy Lab (underwater based zero gravity environment)
- ❑ Remote Field Sites (Flagstaff, Death Valley)
- ❑ Suit Lab



Anthropometry & Biomechanics Facility (ABF)

Products

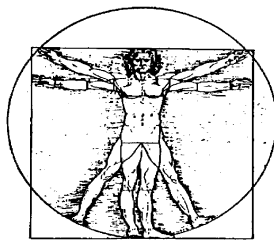
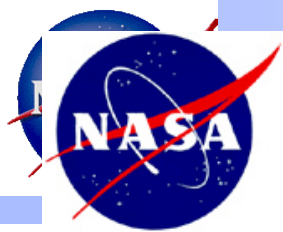
- ❑ Customers are from the engineering, training and research community of NASA.
 - ✓ Anthropometry and Biomechanics data such as strength, fatigue, motion (fig 5)
 - ✓ Analysis and recommendations such as training techniques to optimize performance
 - ✓ Technical reports and research publications



Anthropometry & Biomechanics Facility (ABF)

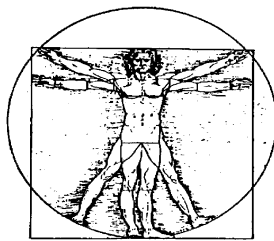
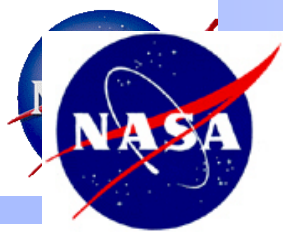
Example

- Hubble Telescope training for crew induced loads during ingress and egress of foot restraint system.
 - ✓ Crew might put excessive on foot restraints installed on Hubble
 - ✓ Instrumented foot restraint to measure loads in NBL
 - ✓ Trained the crew to minimize the load using instrumented foot restraint as guide
 - ✓ Generic training procedures developed for crews using foot restraints during EVA tasks



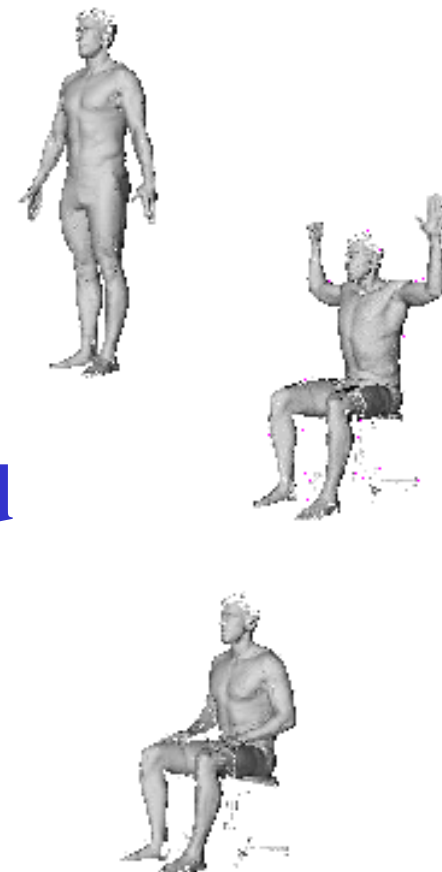
Development of New Analytical Tools to Develop Space Hardware for Future Missions

Sudhakar L. Rajulu, Ph.D.



Objective

- ❑ Enhance NASA's Anthropometric Efforts
- ❑ Development of Comprehensive Anthropometric Database and Analytical Techniques

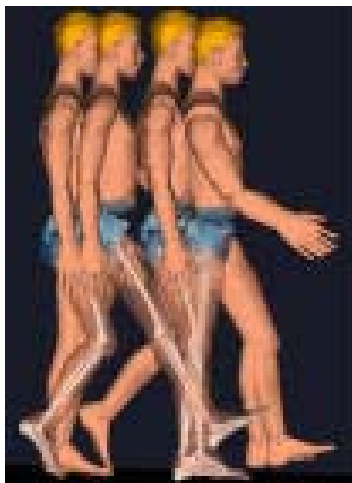
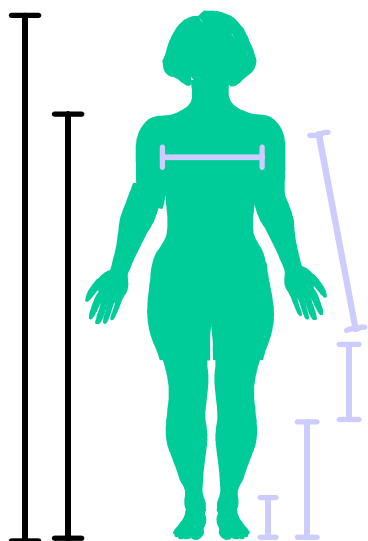
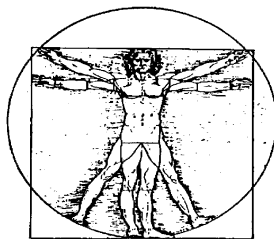
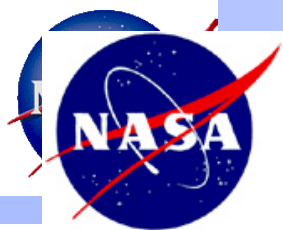




Traditional Anthropometers and
Goniometers are
used for manual measurements

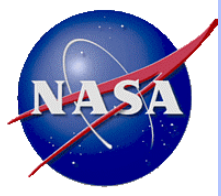


New 3-D Body Scanner



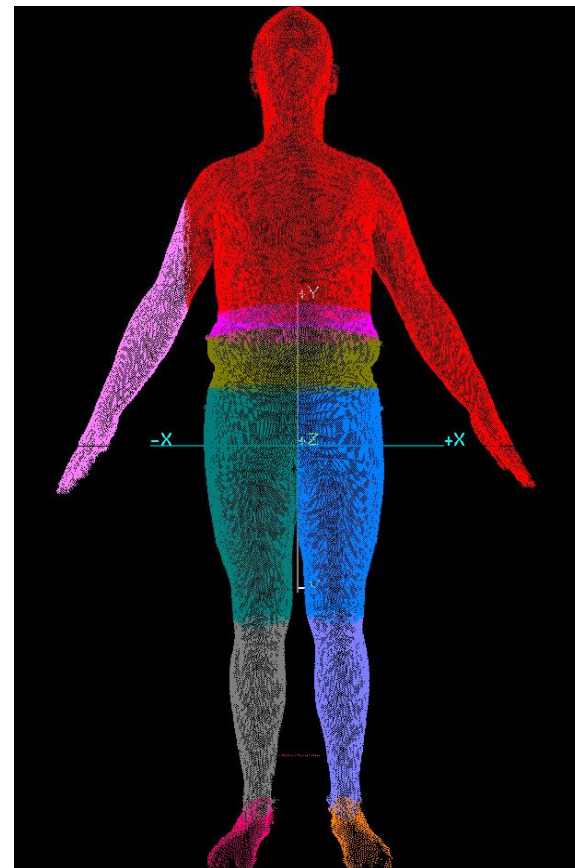
Digital Human Model Animation and Design and Evaluation of Equipment

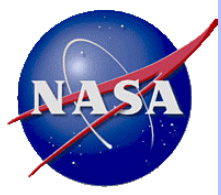




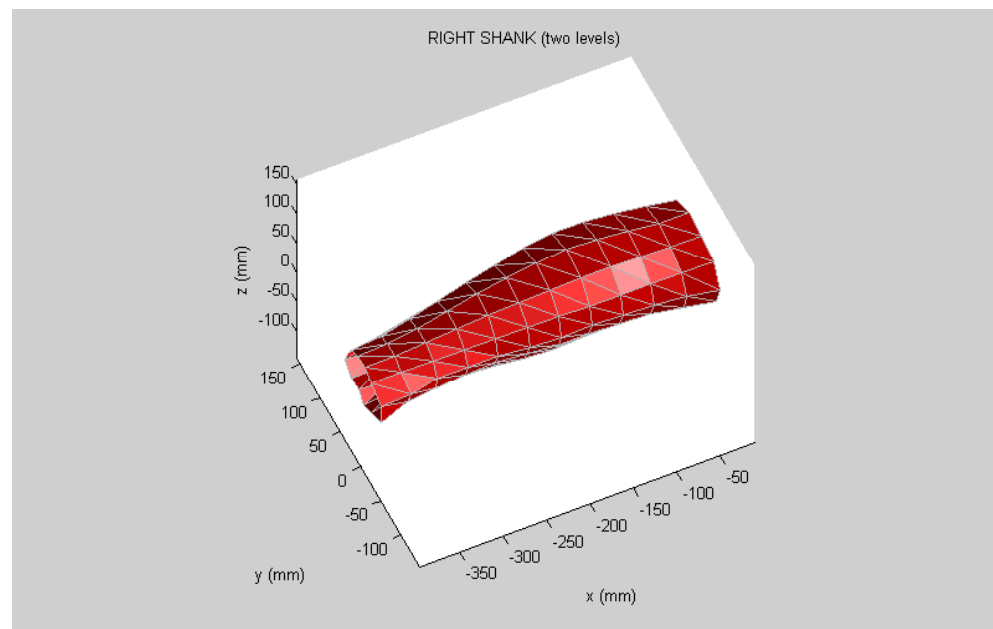
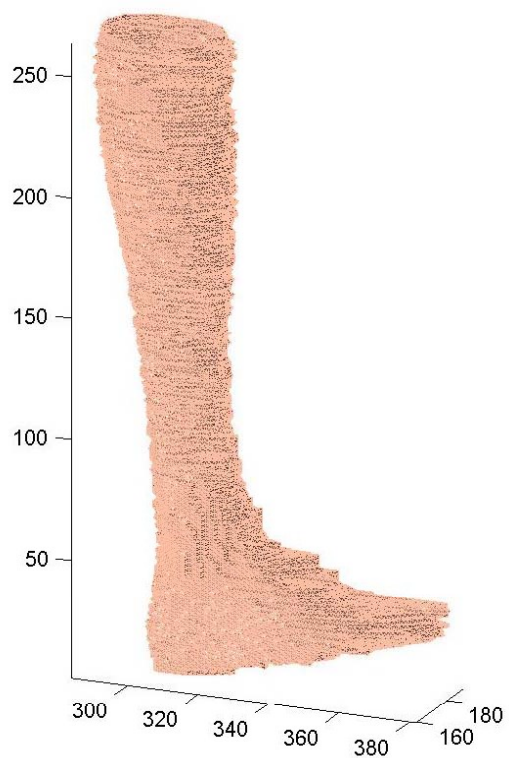
Immediate Goals

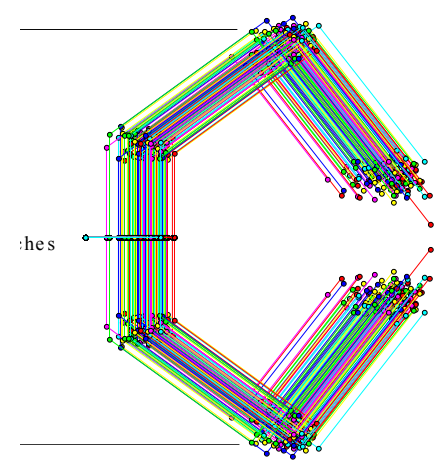
- Segment the body at different anatomical locations.
- Add new landmarks to segment the body at the new landmark locations
- Re-link the segmented parts together for movement at the joint centers.





Accomplishments so far







Anthropometry & Biomechanics Facility (ABF)

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